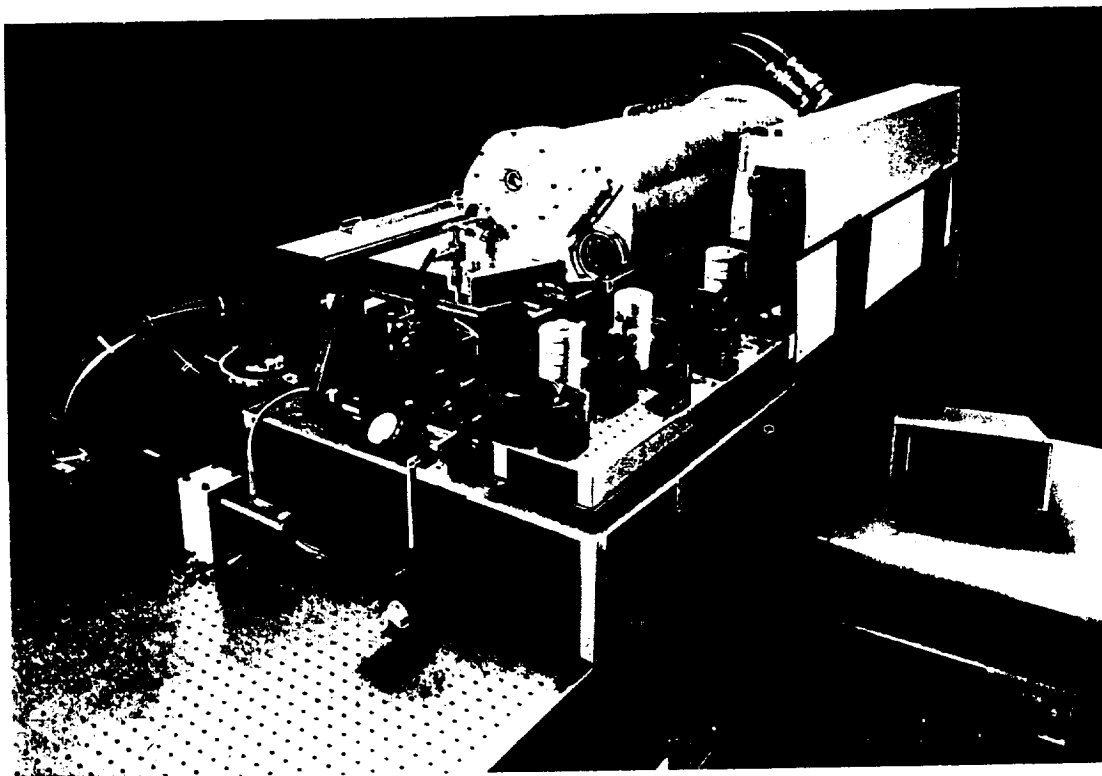


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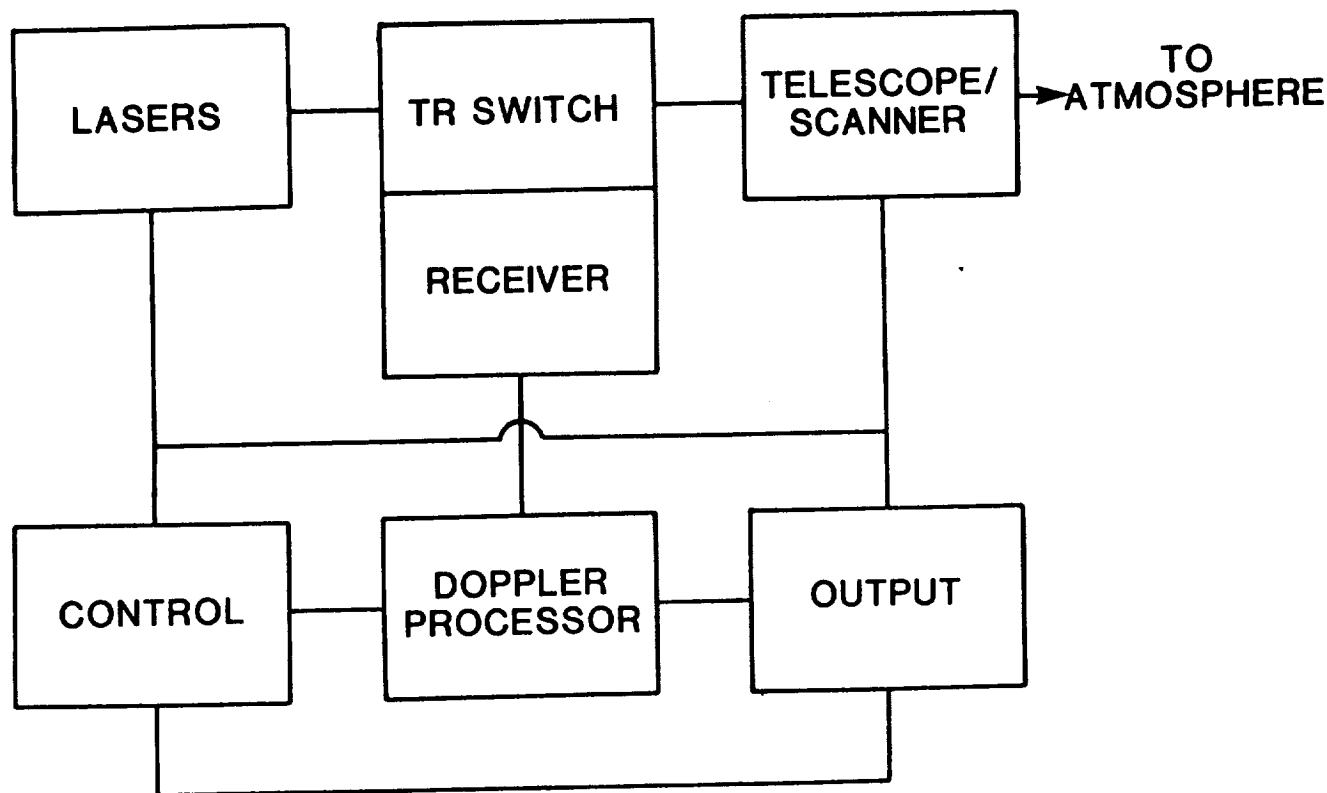
N91-11705

THE "WINDVAN" PULSED CO₂ DOPPLER LIDAR WIDE-AREA WIND SENSOR



1991-11-27 11:00:00

LIDARS FOR REMOTE WIND MEASUREMENT



A Doppler lidar transmits a pulse of light into the atmosphere via a telescope/scanner. The Doppler-shifted collected light is photomixed with the light from a reference local oscillator on the surface of a photodetector, which results in an electronic signal at the Doppler frequency. The required optical beam switching is achieved by the Transmit Receive (TR) switch. The frequency content of the RF signal is measured by the Doppler Processor and normalized to yield the radial velocity of the target. A control computer directs the operation of the lasers, scanner, processor and output devices.

COMPLETE MOBILE WIND MEASUREMENT SYSTEM DEMONSTRATED BY NOAA/WPL

OTHER APPLICATIONS

- Doppler Laser Radar
- DIAL Measurements of Pollutant Concentration

SPECTRA TECHNOLOGY, INC. PROVIDES:

- Complete Integrated Systems
- Advanced Lasers
- Other Lidar Components

PULSED CO₂ DOPPLER LIDAR SPECIFICATIONS

Listed are top-level hardware and performance specifications. A detailed set of specifications reflecting your particular requirements will be provided on request.

LASERS: The transmitter laser is a 2 J per pulse, 50-Hz PRF injection-controlled TE laser operating at 10.6 μ . Injection and local oscillator lasers are 5-W cw devices.

TELESCOPE/SCANNER: The transmit/receive telescope is a 0.30-m diameter off-axis Cassegrain. Beam scanning is accomplished by an AZ-EL mount to achieve complete hemispherical scanning. Scan pattern is programmable.

RECEIVER/TR SWITCH: Transport of transmit beam to the atmosphere, received beam from the atmosphere to the detector and of the local oscillator to the detector achieved by a ZnSe Brewster plate, $\lambda/4$ -plate TR switch. Detector is thermoelectrically cooled.

DOPPLER PROCESSOR: Real time digital Doppler processing. Particular algorithms can be tailored to customer requirements.

CONTROL: Total instrument control by a central computer.

OUTPUT: Per customer requirements. Options include hard copies of tabular and graphical wind profiles, computer-controlled color displays and magnetic tape.

INSTALLATION: Per customer requirements, laboratory, mobile or airborne.

TIME FOR VERTICAL WIND PROFILE: 30 s

RANGE RESOLUTION: 150 m

MAXIMUM RADIAL WIND SPEED AND ACCURACY: ± 50 m/s, ± 0.3 m/s.

PRICE: Subject to your installation requirements. Spectra Technology would be pleased to quote on your precise requirements.

PERFORMANCE EXPECTATIONS:

A CO₂ Doppler lidar is by its very nature a clear air device with limited propagation capabilities through, e.g., fog and clouds. In clear air conditions, the range of the device is dependent on the prevailing atmospheric aerosol content. Typically, the standard performance model could be expected to achieve a range in excess of 25 km in the boundary layer and routinely obtain wind profiles to 10 km altitude (i.e., the troposphere).

EXTENDED PERFORMANCE MODEL:

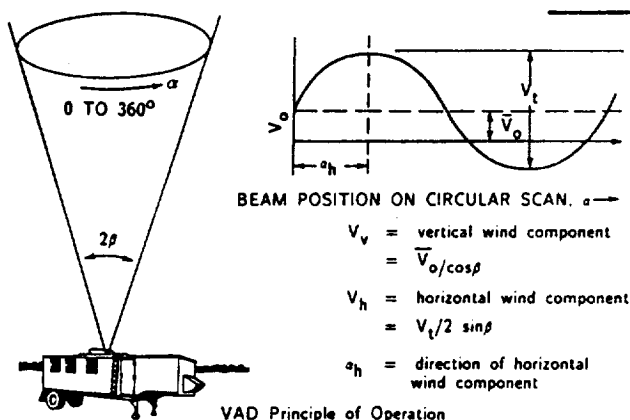
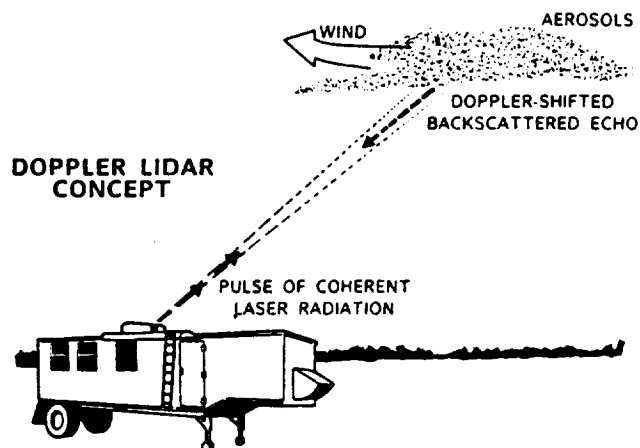
For support of high value missions at long range and upper altitude an extended performance version is recommended. Extended performance is achieved in several ways:

- Increased pulse energy and repetition rate (to 5 J and 100 Hz)
- Increased telescope aperture (to 1 m for 10 dB sensitivity gain)
- Isotopic gas mix (to minimize atmospheric absorption and increase aerosol reflectivity)

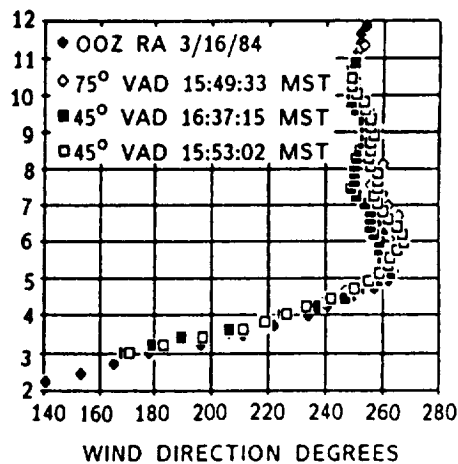
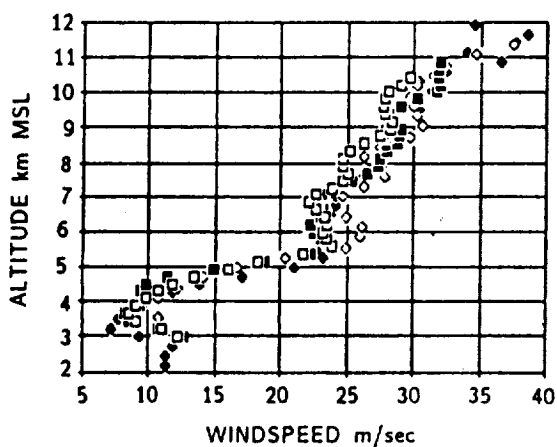
Incorporation of all features results in a sensitivity increase of up to 30 dB. STI would be pleased to quote on your precise requirements.

WIND SENSING USING A DOPPLER LIDAR

Wind sensing using a Doppler lidar is achieved by sensing the Doppler content of narrow frequency laser light backscattered by the ambient atmospheric aerosols. The derived radial wind components along several directions are used to generate wind vectors, typically using the Velocity Azimuth Display (VAD) method described below. Range resolved information is obtained by range gating the continuous scattered return. For a CO_2 laser (10.6μ) the Doppler velocity scaling factor is 188 kHz/ms^{-1} .



In the VAD scan method the zenith angle of the pointing direction is fixed and its azimuth is continuously varied through 2π . A spatially uniform wind field at a particular altitude yields a sinusoidal variation of the radial component vs. azimuth. The amplitude, phase and DC component of this sinusoid yield the horizontal wind speed, direction and vertical component of the wind respectively. In a nonuniform wind field the Fourier components of the variation yields the required information.



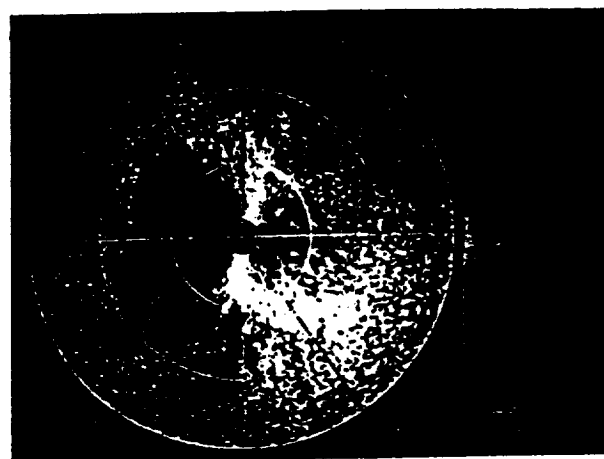
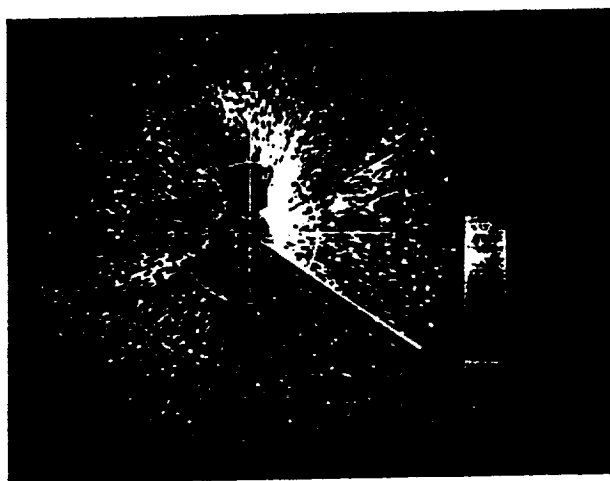
An extensive series of measurements at the National Weather Service Forecast office at Stapleton airport, Denver has demonstrated excellent agreement between Doppler lidar and Rawinsonde outputs.

DATA: Courtesy National Oceanic and Atmospheric Administration/
 Wave Propagation Laboratory

EXAMPLES OF DOPPLER LIDAR OUTPUT

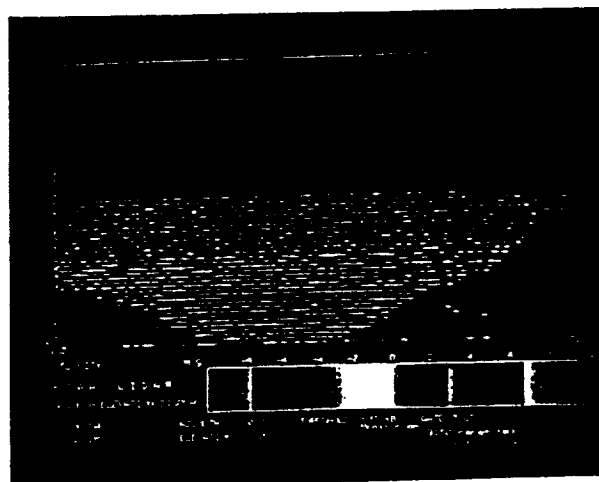
(Courtesy of the National Oceanic and Atmospheric Administration/
Wave Propagation Laboratory)

In the PPI display at the right, the velocity in each range-azimuth cell is color coded according to the scale at the right. The green-blue scale indicates flow toward the lidar (located at the center) and the yellow-red scale flow away from the lidar. This particular example indicates west/north westerly flow. Range rings are at 10-km intervals. Wind measurement to a range approaching 25 km is indicated.



The dramatic feature at an azimuth of 280° (as shown in the photograph on the left) is the outflow from a down burst. This phenomenon when it occurs within the landing corridors at airports can have catastrophic consequences. The blacked out sector, toward the SSE, is due to terrain blockage.

The photograph on the right shows scan and processor flexibility, which allows tailoring of output to unique requirements. In this example, a raster scan at a range of 3.2 km, down a canyon, shows the nocturnal jet. Note the shear that occurs at the plateau level above the canyon.



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